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U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

ATTORNEY'S DOCKET NUMBER

**TRANSMITTAL LETTER TO THE UNITED STATES
DESIGNATED/ELECTED OFFICE (DO/EO/US)
CONCERNING A FILING UNDER 35 U.S.C. 371**

027650-857

U.S. APPLICATION NO. (if known, see 37 C.F.R. 1.5)

Unassigned 09/530361

INTERNATIONAL APPLICATION NO.
PCT/EP98/06846INTERNATIONAL FILING DATE
28 October 1998 (28.10.98)PRIORITY DATE CLAIMED
29 October 1997 (29.10.97)

TITLE OF INVENTION

METHOD AND APPARATUS FOR STERILIZING A PACKAGING SHEET MATERIAL

APPLICANT(S) FOR DO/EO/US

Guido MORUZZI

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
 2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
 3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and the PCT Articles 22 and 39(1).
 4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
 5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
 - a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau).
 - b. ☒ has been transmitted by the International Bureau.
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
 6. ☐ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
 7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
 - a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
 - b. ☐ have been transmitted by the International Bureau.
 - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
 - d. ☒ have not been made and will not be made.
 8. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
 9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
 10. ☐ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).
- Items 11. to 16. below concern other document(s) or information included:
11. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
 12. ☒ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
 13. ☒ A FIRST preliminary amendment.
☐ A SECOND or SUBSEQUENT preliminary amendment.
 14. ☐ A substitute specification.
 15. ☐ A change of power of attorney and/or address letter.
 16. ☒ Other items or information:

International Preliminary Examination Report and attached Amended Sheets; Form PCT/PEA/401; Publ. Appln. WO 99/21593

U.S. APPLICATION NO. (If known, enter PCT No. and date of international filing)
Unassigned **09/530361**INTERNATIONAL APPLICATION NO.
PCT/EP98/06846ATTORNEY'S DOCKET NUMBER
027650-85717. ☒ The following fees are submitted:

CALCULATIONS

PTO USE ONLY

Basic National Fee (37 CFR 1.492(a)(1)-(5)):

Search Report has been prepared by the EPO or JPO \$840.00 (970)

International preliminary examination fee paid to USPTO (37 CFR 1.482)

No international preliminary examination fee paid to USPTO (37 CFR 1.482)

but international search fee paid to USPTO (37 CFR 1.445(a)(2)) \$760.00 (958)

Neither international preliminary examination fee (37 CFR 1.482) nor
international search fee (37 CFR 1.445(a)(2)) paid to USPTO \$970.00 (960)International preliminary examination fee paid to USPTO (37 CFR 1.482)
and all claims satisfied provisions of PCT Article 33(2)-(4) \$96.00 (962)**ENTER APPROPRIATE BASIC FEE AMOUNT =****\$ 840.00**Surcharge of \$130.00 (154) for furnishing the oath or declaration later than
months from the earliest claimed priority date (37 CFR 1.492(e)).20 ☐ 30 ☐

\$ 0.00

Claims	Number Filed	Number Extra	Rate		
Total Claims	19 -20 =	0	X\$18.00 (966)	\$ 0.00	
Independent Claims	1 -3 =	0	X\$78.00 (964)	\$ 0.00	
Multiple dependent claim(s) (if applicable)			+ \$260.00 (968)	\$ 0.00	

TOTAL OF ABOVE CALCULATIONS =**\$ 840.00**Reduction for 1/2 for filing by small entity, if applicable. Verified Small Entity statement must also be
filed. (Note 37 CFR 1.9, 1.27, 1.28).

\$ 0.00

SUBTOTAL =**\$ 840.00**Processing fee of \$130.00 (156) for furnishing the English translation later than
months from the earliest claimed priority date (37 CFR 1.492(f)).20 ☐ 30 ☐

\$ 0.00

TOTAL NATIONAL FEE =**\$ 840.00**Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by
an appropriate cover sheet (37 CFR 3.28, 3.31). per property +

\$ 40.00

TOTAL FEES ENCLOSED =**\$ 880.00**

Amount to be:

refunded \$

charged \$

a. ☒ A check in the amount of \$ 880.00 to cover the above fees is enclosed.b. ☐ Please charge my Deposit Account No. 02-4800 in the amount of \$ _____ to cover the above fees. A duplicate copy of this
sheet is enclosed.c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit
Account No. 02-4800. A duplicate copy of this sheet is enclosed.**NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be
filed and granted to restore the application to pending status.**

SEND ALL CORRESPONDENCE TO:

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SIGNATURE

Robert S. Swecker

NAME

Date: April 28, 2000

19,885

REGISTRATION NUMBER

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re Application Of :
GUIDO MORUZZI : Group Art Unit: Unassigned
Serial No. UNASSIGNED :
Filed: April 28, 2000 :
For: METHOD AND APPARATUS FOR :
STERILIZING A PACKAGING SHEET :
MATERIAL :

PRELIMINARY AMENDMENT

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Prior to examination, please amend the above-identified application as follows:

IN THE SPECIFICATION:

Page 7, line 25, after "320nm", insert --and in that said means for irradiating are arranged only downstream of the means for removing--.

IN THE CLAIMS:

Claim 4, line 1, delete "2 or 3,".

Claim 9, line 1, delete "one or more of claims 1-8", and insert --claim 1--.

Claim 10, line 1, delete "one or more of claims 1-8", and insert --claim 1--.

Claim 11 (Amended) - Apparatus for sterilizing a packaging sheet material according to the method defined in [claims 1-10] claim 1, comprising:

--means for applying hydrogen peroxide to a packaging sheet material moving in an advancement direction,

--means for irradiating the packaging sheet material with light including at least one UV wavelength between 200nm and 320nm, arranged downstream of said means for applying hydrogen peroxide, with respect to said advancement direction, and;

-means for removing the hydrogen peroxide from the surface of the packaging sheet material,

[characterized in that] said means for removing the hydrogen peroxide from the surface of the packaging sheet material [are] being interposed between said means for applying hydrogen peroxide and said means for irradiating the packaging material with light including at least one UV wavelength between 200nm and 320nm and in that said means for irradiating are arranged only downstream of the means for removing, whereby a residual or trace quantity of hydrogen peroxide absorbed by or located adjacent to any microorganisms present on said packaging sheet material is directly targeted with UV radiation.

Claim 14, line 1, delete "or 13".

Claim 15, line 1, delete "13 or 14,".

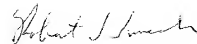
REMARKS

The above amendments have been made to remove the multiple dependencies in the claims and to make the amendments to the specification and claims as previously filed by applicant in response to the International Preliminary Examination Report in PCT Appln. No. PCT/EP98/06846. Early and favorable action in connection with this application is respectfully requested.

Respectfully submitted,

BURNS, DOANE, SWECKER & MATHIS, L.L.P.

By



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Date: April 28, 2000

METHOD AND APPARATUS FOR STERILIZING A PACKAGING SHEET MATERIAL.

TECHNICAL FIELD.

5 The present invention relates to an improved method and apparatus for sterilizing a packaging sheet material of the kind used for packaging pourable food products such as milk, tomato puree, yoghurt, fruit juices, wine, tea, etc. Such laminated packaging sheet material has a multi-layered structure including a fibre-based layer made of a material such as paper, which is coated on either
10 side with a heat-sealable plastics material such as polyethylene. When the packaging material is to be used for the aseptic packaging of pourable products such as milk treated at ultra-high temperature (UHT milk), the face of the packaging material destined to be placed in contact with the food product is also provided with a layer of barrier material, such as e.g., aluminium, which is
15 in turn covered with a layer of plastics material such as polyethylene.

When manufacturing packages from the above-mentioned kind of packaging sheet material, it is imperative that no microorganisms are allowed to come into contact with the food product to be packaged. Therefore, the packaging material must be sterilized immediately prior to use for the
20 manufacture of packages, and it must be retained in sterile conditions, until the package is completely sealed, thereby ensuring that the food product contained therein is free from any microorganisms which would otherwise spoil the food and/or transmit diseases to the consumer.

25 BACKGROUND ART.

Laminated packaging material may be produced in the form of web which can be continuously fed into a package forming, filling and sealing machine. Such machines include e.g., the TBA/19[®] and TBA/21[®] filling machine, manufactured by Tetra Brik Packaging Systems, Via Delfini 1, Modena, Italy.
30 The web is sterilized with a sterilizing agent such as e.g., hydrogen peroxide, which is thereafter removed by evaporation. The sterile packaging material is then maintained in an aseptic chamber, then longitudinally sealed to form a continuous tube, which is filled with liquid food product to be packaged.

The tube is then clamped and transversely sealed at regular intervals to produce pillow-shaped packages, which are mechanically folded to produce finished packages. Such types of packages include e.g., parallelepiped packages known by the registered trademarks Tetra Brik Aseptic® and Tetra Brik®, and substantially parallelepiped packages with bevelled corners commonly known by the registered trademarks Tetra Prisma® and Tetra Prisma Aseptic®.

Alternatively, the laminated packaging sheet material may be cut into blanks and then formed into packages on mandrels. Such packages are sterilized by spraying with hydrogen peroxide. The spray produces a thin layer of hydrogen peroxide on the hydrophobic, thermoplastic outer layer of the packaging sheet material. Successively, a source of UV light in the 200-325nm range is irradiated onto the hydrogen peroxide-covered outer layer of packaging material. The synergy occurring between the hydrogen peroxide and the UV light achieves has a killing effect on any microorganisms on the packaging material. Thereafter, the hydrogen peroxide is removed and the packages are filled with liquid food product and sealed to produce gable-top container commonly known by the registered trademark Tetra Rex®.

20 Sterilization with hydrogen peroxide:

In the sterilization systems employing hydrogen peroxide, without any irradiation thereon of UV light, efforts have been made to prolong the time that the hydrogen peroxide remains in contact with the packaging material, in order to increase the killing effect of the sterilization process. United States patent No. 3,904,361 describes a process wherein, in order to prevent or at least minimize evaporation of a peroxide film on a packaging material web during its passage through a sterilization chamber, to prolong its contact with the web face and obtain the desired sterilization, the chamber is saturated with steam and hydrogen peroxide vapours obtained by spraying hydrogen peroxide through nozzles into the chamber. Although this technique prolonged contact of a very hot film of hydrogen peroxide with the packaging web surface to improve sterilization, it imposed severe restrictions on the rate at which packages could be manufactured with the packaging machine.

Another problem encountered with the known sterilization techniques employing hydrogen peroxide, regards ensuring uniformity of the degree of sterilization throughout the packaging material. In some web-fed packaging machines, hydrogen peroxide was mixed with water and delivered drop-wise into a heated container placed in the longitudinally sealed tube of packaging material. However, the vaporized hydrogen peroxide only started to have a sterilizing effect when the major part of the water in the droplets had evaporated. Therefore, the concentration of hydrogen peroxide actually acting on the packaging material varied considerably, at the same rate as delivery of drops of sterilizing agent. In order to overcome this problem US Patent No. 4,225,556 disclosed the use of a first treatment station with a container for hydrogen peroxide through which the packaging material was passed, and a second treatment station comprising a chamber with an inlet and an outlet for the packaging material web, and a nozzle for spraying hydrogen peroxide onto a heated surface. However, neither this arrangement, nor the above-described sterilization technique known from United States patent No. 3904361 are compatible with modern high-speed liquid food packaging machines due to the excessive times required to effect sterilization.

In order to overcome problems regarding uniformity of the sterilization of a packaging material web with hydrogen peroxide, the packaging material is passed through a bath containing hydrogen peroxide sterilizing solution, and in order to cope with ever-increasing production rates, the hydrogen peroxide baths have been increased in size to maintain contact time between the packaging material and the sterilizing solution. The intensified contact between the hydrogen peroxide solution and the packaging material is of course an advantage from the point of view of bacteriological killing. However, the intensified contact also increases the risk that the hydrogen peroxide solution will penetrate into and degrade the liquid-absorbent fibrous layer of the packaging material web through the cut edges of the web. The overdimensioning of the bath also results in a further increase in hydrostatic pressure which further increases the risk of liquid penetrating into the web in the deeper parts of the bath. Furthermore, since packaging material located in the

bath during machine stoppages is discarded, the deeper baths caused greater wastage of material upon each machine stop.

Sterilization with hydrogen peroxide and UV radiation:

- 5 United States patent No. 4,289,728 to Peel et al dealt with the synergy that exists between UV radiation below 325nm, and hydrogen peroxide at a concentration of at least 0.01% and no more than 10% by weight. By treating a microorganism at the surface of the packaging with an ultraviolet irradiated solution of hydrogen peroxide, the microorganism is rendered non-viable by the
10 synergism between the radiation and the hydrogen peroxide.

- However, even with the use of powerful UV lamps, a long irradiation time was required for thorough sterilization, and this long irradiation time gave rise to damaging of the packaging material, lowering of its heat-seal strength and discoloration thereof. As a solution to this problem, United States patent No.
15 4,366,125 to Kodera et al disclosed a system including a first station for applying a thin film of hydrogen peroxide at low concentration at room temperature onto the outer surfaces of a packaging material. A second station, located downstream of the first station with respect to a travel direction defined by the material to be sterilized, was provided for irradiating the outer hydrogen
20 peroxide-coated surfaces with UV radiation. Finally, a third station was provided downstream of the second station for drying the material with aseptic hot air.
- United States patent No. 5,114,670 to Duffey disclosed a sterilization chamber including inlet and outlet means for the material to be sterilized, means for introducing gaseous hydrogen peroxide into the sterilization chamber, and
25 means for simultaneously irradiating the material to be sterilized with UV energy.

- WO 97/35768 discloses a method of sterilizing food packaging containers comprising a first step of depositing a hydrogen peroxide-containing solution having a concentration in a range of 0.05 – 0.20 wt.% into an interior of
30 a packaging container; a second step of irradiating the interior of the container with ultraviolet light after the hydrogen peroxide-containing solution is deposited in the interior of the container, and a third step of removing hydrogen peroxide from the interior of the container.

However, since the removing of hydrogen peroxide is performed after the irradiating with UV light, any microorganisms present on the packaging material are, at least to some extent, shielded by the layer of excess hydrogen peroxide covering the packaging material. Furthermore, the method is applied to
5 intermittently transferred and stopped packaging containers, and is not suitable for sterilizing a continuously moving web or sheet of packaging material.

Methods of sterilizing packaging material are also known from Patent Abstracts of Japan vol. 014, no. 135 (M-0949), 14 March 1990 & JP-A-02 004621, and also from Database WPI, section Ch. Week 8707, Derwent
10 Publications Ltd., London, GB; Class D22, AN 87-046573, XP002061293 & JP-A-62004038 (Dainippon Printing Co LTD.), 10 January 1987. In both of these methods, the step of irradiating with UV light is performed prior to removal of hydrogen peroxide from the surface of the packaging material. This has the disadvantage that any microorganisms present on the packaging material are to
15 some extent shielded from the UV radiation by the layer of excess hydrogen peroxide on the packaging material. Furthermore, these known methods are disclosed for sterilizing stationary packaging containers and are not suitable for sterilizing a continuously moving web or sheet of packaging material in a modern, high-speed machine for packaging liquid food products in packages
20 made from a continuous web of packaging material.

All of the above-mentioned sterilization techniques are susceptible to improvement relating to the killing effect achieved and the time necessary to guarantee elimination of all pathogenic microorganisms, on the packaging material, for compatibility with modern high-speed liquid food packaging
25 machines which can form, fill and seal 18000 or even more aseptic packages per hour, and wherein the packaging material moves at a speed of, or greater than 81.65 cm per second (48.990 meters per minute), such as the package forming, filling and sealing machine described in European patent application No. 97830312.1, filed on June 27, 1997, by the same applicant.

30 DISCLOSURE OF THE INVENTION.

There is a general need in the art to provide a method and apparatus for sterilizing packaging sheet material, which overcomes the problems encountered in the prior art sterilization methods and apparatuses.

A main object of the invention is to provide a method and apparatus for sterilizing packaging sheet material, which achieves improved killing rates with respect to the known sterilization techniques, thereby improving the quality of sealed packages manufactured with the packaging sheet material and hence
5 the product delivered to the consumer.

Another object of the invention is to provide a method and apparatus for sterilizing packaging sheet material which is fully compatible with modern high-speed package forming, filling and sealing machines.

A further object of the invention is to provide a method and apparatus for
10 sterilizing packaging sheet material employing hydrogen peroxide, which minimizes the time that the sheet material remains in contact with the hydrogen peroxide, thereby avoiding any soaking of the hydrogen peroxide into the cut edge of the packaging sheet material. This is a clear advantage, irrespective of the means which are used to apply hydrogen peroxide to the packaging
15 material, but it is particularly advantageous when a hydrogen peroxide bath is used. The invention allows to construct a bath of reduced depth, whereby no problems arise relating to hydrostatic pressures which would otherwise tend to promote soaking of the hydrogen peroxide into the cut edge of the packaging sheet material.

Yet another object of the invention is to provide a method and apparatus
20 for sterilizing packaging sheet material employing hydrogen peroxide and UV radiation, wherein commercially available means for generating UV radiation can be used, at a power level which does not have any detrimental effects on the packaging material.

A further object of the invention is to provide a method and apparatus for
25 sterilizing packaging sheet material employing hydrogen peroxide and UV radiation, which can be integrated with current package forming, filling and sealing machines.

With the above-mentioned objects in view, as well as other objects of the
30 invention which will become apparent hereinafter, the invention provides a method of sterilizing a packaging sheet material, comprising the steps of;
-applying hydrogen peroxide to a packaging sheet material, and;

-irradiating the packaging sheet material with light including at least one UV wavelength between about 200nm and 320nm,

characterized in that it comprises the intermediate step of removing the hydrogen peroxide from the surface of the packaging sheet material while retaining a residual or trace quantity at any microorganisms (30a), after the step of applying hydrogen peroxide and before the step of irradiating the packaging material, whereby said residual or trace quantity of hydrogen peroxide absorbed by or located adjacent to any microorganisms present on said packaging sheet material is directly targeted with UV radiation.

According to another aspect of the present invention, there is also provided an apparatus for sterilizing a packaging sheet material which comprises

- means for applying hydrogen peroxide to a packaging sheet material moving in an advancement direction,

- means for irradiating the packaging sheet material with light including at least one UV wavelength between 200nm and 320nm, arranged downstream of said means for applying hydrogen peroxide, with respect to said advancement direction, and;

- means for removing the hydrogen peroxide from surface of the packaging sheet material,

characterized in that said means for removing the hydrogen peroxide from the surface of the packaging sheet material are interposed between said means for applying hydrogen peroxide and said means for irradiating the packaging material with light including at least one UV wavelength between 200nm and 320nm, whereby a residual or trace quantity of hydrogen peroxide absorbed by or located adjacent to any microorganisms present on said packaging sheet material is directly targeted with UV radiation.

BRIEF DESCRIPTION OF THE DRAWINGS.

Further features and advantages of the invention will become apparent from the following detailed description of the invention, and the accompanying drawing figures wherein:

Figure 1 is a schematic view of the apparatus according to the invention;

< and in that said means for irradiating are arranged only downstream of the means for removing >

AMENDED SHEET

Figure 2 is an enlarged, schematic cross-sectional view of a portion of packaging sheet material irradiated with UV light according to the methods of the prior art, and;

Figure 3 is an enlarged, schematic cross-sectional view of a portion of
5 packaging sheet material irradiated with UV light according to the method of the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION.

With reference to drawing figure 1, the apparatus according to the invention is shown together with a packaging material sheet to be sterilized.
10 Although, in the illustrated example, the packaging material is in the form of a web 1, it will be appreciated that the material may also be in the form of a cut blank. As shown in figure 3, the web 1 is a laminated multi-layer material of the type commonly used for aseptic packaging of pourable food products. The laminated structure has a fibre-based layer 20 made of a material such as
15 paper, and heat-sealable layers 21, 22 made of plastics material such as polyethylene, provided on each side of the fibre-based layer 20. When the packaging material is to be used for the aseptic packaging of pourable products such as milk treated at ultra-high temperature (UHT milk), the face of the packaging material destined to be placed in contact with the food product is
20 also provided with a layer of barrier material 23, such as e.g., aluminium, which is in turn covered with an additional heat-sealable layer 24 of plastics material such as polyethylene.

The web 1 is moved in an advancement direction, indicated by the arrow 2, and guided in its trajectory, by conventional means which do not form part of
25 the present invention and thus are not illustrated. As clearly shown in figure 1, the apparatus according to the invention includes means for applying hydrogen peroxide to the surface of the packaging sheet material 1, moving in the advancement direction 2, which are preferably constituted by a bath 3 containing liquid hydrogen peroxide 4. The hydrogen peroxide 4 in the bath 3 may have a concentration of up to 50% by weight, and preferably has a
30 concentration of from 10% by weight to 50% by weight, and most preferably has a concentration of from 20% by weight to 40% by weight. A conventional roller 5 is provided in the bath for guiding the packaging material 1. As also

schematically shown in figure 1, means 6 are also connected to the bath 3 for maintaining the hydrogen peroxide at a temperature preferably comprised between 15 degrees Centigrade and 80 degrees Centigrade, and may be constituted by a conventional thermostatically-controlled heating mechanism 6 as commonly used in the technical field of the invention, such as those present on the above cited TBA/19[®] and TBA/21[®] liquid food packaging machines, available from Tetra Brik Packaging Systems, Via Delfini 1, Modena, Italy.

In the apparatus according to the invention, the depth of the hydrogen peroxide bath can be reduced with respect to conventional baths, and the hydrogen peroxide 4 in the bath 3 preferably defines a liquid column having a height less than 50cm. One skilled in the art will appreciate that other means for applying hydrogen peroxide liquid or vapour to the surface of the packaging material may also be used, such as spray means.

Means for irradiating the packaging sheet material with light, including at least one UV wavelength between 200nm and 320nm, are located downstream of the bath 4, with respect to the advancement direction 2, and comprise a UV light source 7. According to a preferred embodiment of the invention, the UV light source 7 for irradiating the packaging sheet material may comprises a monochromatic source of UV light having a wavelength of 222nm. The monochromatic source of UV light having a wavelength of 222nm preferably comprises at least one excimer lamp. Such lamps are available from Heraeus Noblelight, Kleinostheim, Germany. Alternatively, a source of polychromatic UV light may also be used. Such polychromatic lamps are manufactured, for instance, by Berson UV-techniek, De Huufkes 23, NL-5674Nuenen, The Netherlands. Other lamps or lasers may also be used which emit light in the UV wavelengths.

As shown in figure 1, means 8 are also provided for removing hydrogen peroxide from the surface of the packaging sheet material 1, or, as will be explained hereinafter, reducing the hydrogen peroxide on the surface of the packaging sheet material to a minimum. In the illustrated example, the means 8 for removing hydrogen peroxide from the packaging sheet material preferably comprise at least one air knife 9 for blowing air onto the packaging material sheet 1. Such air knives are known from United States patent No. 4603490 to

Hilmersson et al, and have a chamber 10 including an air inlet 11 and an air outlet 12 for a flow of air, a material inlet 13 and a material outlet 14 for a packaging material web 1, and a baffle plate 15 disposed over the air outlet 12 at an angle in relation to the path of travel of the web 1 through the chamber 10.

5 Air blown onto the web 1 at the air knife is preferably heated to a temperature of from 80 degrees Centigrade to 150 degrees Centigrade. It will be appreciated that other means for removing the hydrogen peroxide from the web 1 may also be used. For example, conventional squeegee rollers or pinch rollers, may also be used in addition to or instead of the air knife. Other means
10 may also be used for generating a flow of hot air suitable for evaporating the hydrogen peroxide. However, means for blowing hot air onto the packaging material web is preferred, especially where the web has any parts, such as package opening devices injection-molded directly onto the web, which could affect the efficiency of the squeegee rollers.

15 An important feature of the present invention resides in the specific location of the means for removing excess hydrogen peroxide from the surface of the packaging material web 1. As clearly shown in figure 1, the means for removing excess hydrogen peroxide 8 are interposed between the means for applying hydrogen peroxide, constituted in the illustrated example by the bath 3,
20 and the means 7 for irradiating the packaging material with light including at least one UV wavelength between 200nm and 320nm. The reason for this location of the means for removing hydrogen peroxide is the following:

With reference first of all to drawing figure 2, there is illustrated an enlarged sectional view of a portion of a multi-layer laminated packaging sheet
25 material like the above-described web 1, wherein identical layers of the laminated structure are identified by the same reference numerals. Additionally, the reference numeral 30 schematically indicates microorganisms present on the surface of the packaging material, and the reference numeral 31 indicates the layer of hydrogen peroxide applied to the surface of the packaging material.

30 Figure 2 illustrates the treatment of a packaging sheet material according to the prior art methods, wherein hydrogen peroxide at a concentration no greater than 10% by weight is first applied to the packaging sheet material. Thereafter the hydrogen peroxide is irradiated with UV light, and the synergy between the

hydrogen peroxide and the UV light has the known killing effect on the microorganisms 30.

Figure 3 illustrates the treatment of a packaging sheet material according to the invention, wherein hydrogen peroxide, preferably at a concentration of up to 50% by weight, and preferably of from 10% to 50% by weight, is first applied to the packaging sheet material. Thereafter the hydrogen peroxide is removed from the surface of the packaging material. It would thus appear that if one irradiated the packaging material with UV light at this point, i.e., in the UV irradiation zone indicated by the reference numeral 19 in figure 1, there could be no interaction between the UV light and hydrogen peroxide, because the latter has been removed. However, the applicant has discovered that on the contrary, the killing effect achieved is significantly improved with respect to known techniques. This is due to the fact that although excess hydrogen peroxide is removed from the hydrophobic packaging sheet material, a residual or trace quantity is retained at any microorganisms 30a, which are believed to hydrophilically absorb the hydrogen peroxide 31a or otherwise retain the residual hydrogen peroxide. Therefore, when the packaging sheet material is successively irradiated with UV light, the interaction occurring between the hydrogen peroxide and the UV light, that has the known killing effect on microorganisms, is targeted specifically to the microorganisms themselves, which have hydrophilically absorbed or otherwise retained the hydrogen peroxide. Furthermore, the removal of the shielding layer of excess hydrogen peroxide allows advantage to be taken of the possibility of using higher concentrations of hydrogen peroxide than those which were considered to be the maximum utilizable by the prior art.

In other words, instead of irradiating the entire layer of hydrogen peroxide with the aim of killing any microorganisms contained therein, as taught by the prior art, in accordance with the invention, the layer of excess hydrogen peroxide 31 is removed and only the residual hydrogen peroxide located in, on or adjacent to any microorganisms any microorganisms 30a present on the surface of the packaging material is directly targeted with UV radiation. It will be understood that the positional relationship between the residual hydrogen

peroxide and the and the microorganisms shown in figure 3 is purely schematic and representative of what is believed to be occurring.

Therefore, when irradiating the packaging material with UV light, instead of having a layer of excess hydrogen peroxide shielding the microorganisms, the irradiation of UV light is targeted to the residual hydrogen peroxide absorbed by or located adjacent to the microorganisms. The removal of the layer of excess hydrogen peroxide in practice has the surprising effect of significantly increasing the efficiency of the sterilization process.

The method according to the invention, carried out with the above-described apparatus, will now be described:

First of all, hydrogen peroxide, preferably liquid hydrogen peroxide at a concentration of up to 50% by weight, preferably of from 10% by weight to 50% by weight, and most preferably at a concentration of from 20% by weight to 40% by weight, is applied to a packaging sheet material. In accordance with a preferred embodiment of the invention, this is achieved by immersing the packaging sheet material in a hydrogen peroxide bath at a temperature comprised between 15 degrees Centigrade and 80 degrees Centigrade, for a time interval of from 0.5 seconds to 2 seconds. During this time, the hydrogen peroxide is believed to be hydrophilically absorbed in, or become somehow entrapped adjacent to or on any microorganisms present on the packaging material. Preferably, the height of the liquid column of hydrogen peroxide in the bath does not exceed 50cm above the packaging sheet material. Although deeper hydrogen peroxide baths may be used, this relatively short residence time and shallow depth obviate problems relating to edge-soaking or wicking of the hydrogen peroxide into the fibrous layer of the laminated packaging material.

Thereafter, the excess hydrogen peroxide is removed from the surface of the packaging sheet material, preferably by blowing thereon a stream of air heated to a temperature of from 80 degrees Centigrade to 150 degrees Centigrade, to reduce the hydrogen peroxide on the surface of the packaging material to a minimum. This removes the excess hydrogen peroxide from the surface of the packaging material, but a trace quantity of residual hydrogen peroxide is retained at any microorganisms present on the surface of the packaging

material. Once the excess hydrogen peroxide has been removed from the surface of the packaging material, the material is irradiated with light including at least one UV wavelength between about 200nm and 320nm. According

to a preferred embodiment of the invention, the packaging sheet material is

- 5 irradiated with UV light at a wavelength of 222nm, and most preferably, the UV light source is an excimer lamp. In this manner, it has been found that it is possible to directly target residual hydrogen peroxide entrapped at any microorganisms present on the packaging sheet material with UV radiation. The use of an excimer lamp has the additional advantages of instantaneous
- 10 activation and deactivation and no significant heat emission. From experimental tests, it has been observed that when the hydrogen peroxide is not reduced to a minimum (i.e., to a residual or trace quantity at any microorganisms on the packaging material to be sterilized) before irradiating with UV light, a far less log reduction results than that which has been achieved in comparative
- 15 experiments which have been carried out in accordance with the invention.

The sterilization system according to the invention is fully compatible with modern high-speed aseptic liquid-food packaging machines, producing up to 18000 or more packages per hour, wherein the packaging material moves at a speed of, or greater than 81.65 cm per second (48.990 meters per minute).

- 20 The present invention may be further modified, without thereby departing from the purview of the appended claims.

CLAIMS.

What is claimed is:

1. Method of sterilizing a packaging sheet material, comprising the steps of:
 - 5 -applying hydrogen peroxide to a packaging sheet material, and;
 - irradiating the packaging sheet material with light including at least one UV wavelength between about 200nm and 320nm,
characterized in that it comprises the intermediate step of removing the hydrogen peroxide from the surface of the packaging sheet material, while
- 10 retaining a residual or trace quantity at any microorganisms (30a), after the step of applying hydrogen peroxide and before the step of irradiating the packaging material, whereby said residual or trace quantity of hydrogen peroxide absorbed by or located adjacent to any microorganisms present on said packaging sheet material is directly targeted with UV radiation.
- 15 2. Method according to claim 1, **characterized in that** said step of applying hydrogen peroxide to said packaging sheet material comprises applying liquid hydrogen peroxide thereto at a concentration of up to 50% by weight.
3. Method according to claim 1, **characterized in that** said step of applying hydrogen peroxide to said packaging sheet material, comprises applying liquid
- 20 hydrogen peroxide at a concentration of from 20% by weight to 40% by weight.
4. Method according to claim 1, 2 or 3, **characterized in that** said step of applying hydrogen peroxide to said packaging sheet material comprises the step of immersing said packaging sheet material in a hydrogen peroxide bath at a temperature comprised between 15 degrees Centigrade and 80 degrees
- 25 Centigrade, for a time interval of from 0.5 seconds to 2 seconds.
5. Method according to claim 1, **characterized in that** said intermediate step of removing excess hydrogen peroxide from said packaging sheet material comprises blowing a stream of heated air, heated to a temperature of from 80 degrees Centigrade to 150 degrees Centigrade onto said packaging
- 30 sheet material.
6. Method according to claim 1, **characterized in that** said step of irradiating the packaging sheet material with light including at least one UV

wavelength, consists of irradiating said packaging sheet material with polychromatic UV light.

7. Method according to claim 1, **characterized in that** said step of irradiating the packaging sheet material with light including at least one UV wavelength, consists of irradiating said packaging sheet material with UV light at a wavelength of 222nm.

8. Method according to claim 7, **characterized in that** said step of irradiating the packaging sheet material with UV light at a wavelength of 222nm comprises irradiating said packaging sheet material with an excimer lamp.

9. Method according to one or more of claims 1-8, **characterized in that** said packaging sheet material is a web unwound from a roll.

10. Method according to one or more of claims 1-8, **characterized in that** said packaging sheet material is a blank.

11. Apparatus for sterilizing a packaging sheet material according to the method defined in claims 1-10, comprising;

-means for applying hydrogen peroxide to a packaging sheet material moving in an advancement direction,

-means for irradiating the packaging sheet material with light including at least one UV wavelength between 200nm and 320nm, arranged downstream of said

means for applying hydrogen peroxide, with respect to said advancement direction, and;

-means for removing the hydrogen peroxide from the surface of the packaging sheet material,

characterized in that said means for removing the hydrogen peroxide from the surface of the packaging sheet material are interposed between said means for applying hydrogen peroxide and said means for irradiating the packaging material with light including at least one UV wavelength between 200nm and 320nm, whereby a residual or trace quantity of hydrogen peroxide absorbed by or located adjacent to any microorganisms present on said packaging sheet material is directly targeted with UV radiation.

12. Apparatus according to claim 11, **characterized in that** said means for applying hydrogen peroxide to said packaging sheet material comprise a bath containing liquid hydrogen peroxide at a concentration of up to 50% by weight.

<and in that said means for irradiating are arranged only downstream of the means for removing>

ENCLOSED SHEET

13. Apparatus according to claim 11, **characterized in that** said means for applying hydrogen peroxide to said packaging sheet material comprise a bath containing liquid hydrogen peroxide at a concentration of from 20% by weight to 40% by weight.

5 14. Apparatus according to claim 12 or 13, **characterized in that** it comprises means for maintaining said hydrogen peroxide bath at a temperature comprised between 15 degrees Centigrade and 80 degrees Centigrade.

15. Apparatus according to claim 12, 13 or 14, **characterized in that** said hydrogen peroxide in said bath defines a liquid column having a height less
10 than 50cm in said bath.

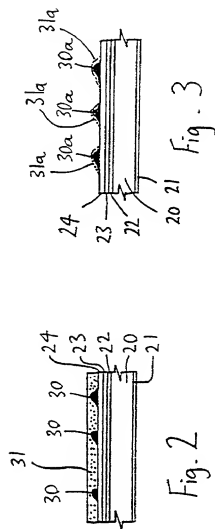
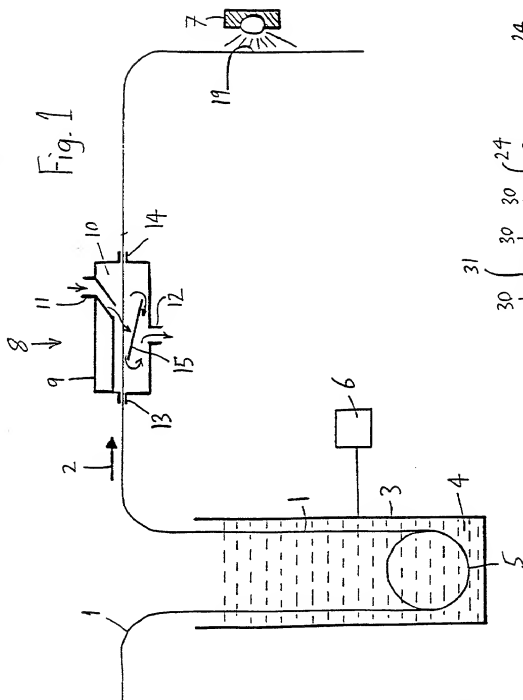
16. Apparatus according to claim 11, **characterized in that** said means for removing hydrogen peroxide from said packaging sheet material comprise at least one air knife for blowing air onto said packaging material sheet at a temperature of from 80 degrees Centigrade to 150 degrees Centigrade.

15 17. Apparatus according to claim 11, **characterized in that** said means for irradiating the packaging sheet material with light include at least one UV wavelength between about 200nm and 320nm comprise a monochromatic source of UV light having a wavelength of 222nm.

18. Apparatus according to claim 17, **characterized in that** said
20 monochromatic source of UV light comprises at least one excimer lamp.

19. Apparatus according to claim 11, **characterized in that** said means for irradiating the packaging sheet material with light including at least one UV wavelength, comprise a polychromatic UV lamp.

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COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY
(Includes Reference to Provisional and PCT International Applications)

ATTORNEY'S DOCKET NUMBER

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name;
I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

METHOD AND APPARATUS FOR STERILIZING A PACKAGING SHEET MATERIAL

the specification of which (check only one item below):

☐ is attached hereto.

☐ was filed as United States application

Number _____

on _____

and was amended

on _____ (if applicable).

☒ was filed as PCT international application

Number PCT/EP98/06846

on 28 OCTOBER 1998

and was amended under PCT Article 19

on _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose to the Office all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, §1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, §119 (a)-(e) of any foreign application(s) for patent or inventor's certificate or of any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed:

PRIOR FOREIGN/PCT APPLICATION(S) AND ANY PRIORITY CLAIMS UNDER 35 U.S.C. §119:

COUNTRY (if PCT, indicate "PCT")	APPLICATION NUMBER	DATE OF FILING (day, month, year)	PRIORITY CLAIMED UNDER 35 U.S.C. §119
EP	97830555.5	29.10.1997	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
			<input type="checkbox"/> Yes <input type="checkbox"/> No
			<input type="checkbox"/> Yes <input type="checkbox"/> No
			<input type="checkbox"/> Yes <input type="checkbox"/> No
			<input type="checkbox"/> Yes <input type="checkbox"/> No

I hereby claim the benefit under Title 35, United States Code § 119(e) of any United States provisional application(s) listed below.

(Application Number) _____

(Filing Date) _____

(Application Number) _____

(Filing Date) _____

COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY (CONTINUED) (Includes Reference to Provisional and PCT International Applications)		ATTORNEY'S DOCKET NO.
FULL NAME OF SOLE OR FIRST INVENTOR Guido MORUZZI	SIGNATURE <i>Guido Moruzzi</i>	DATE 13 March 2006
RESIDENCE Via Venezia, 10 I-40068 S.Lazzaro di Savena (Italy)	CITIZENSHIP ITALIAN	
POST OFFICE ADDRESS		
FULL NAME OF SECOND JOINT INVENTOR, IF ANY	SIGNATURE	DATE
RESIDENCE	CITIZENSHIP	
POST OFFICE ADDRESS		
FULL NAME OF THIRD JOINT INVENTOR, IF ANY	SIGNATURE	DATE
RESIDENCE	CITIZENSHIP	
POST OFFICE ADDRESS		
FULL NAME OF FOURTH JOINT INVENTOR, IF ANY	SIGNATURE	DATE
RESIDENCE	CITIZENSHIP	
POST OFFICE ADDRESS		
FULL NAME OF FIFTH JOINT INVENTOR, IF ANY	SIGNATURE	DATE
RESIDENCE	CITIZENSHIP	
POST OFFICE ADDRESS		
FULL NAME OF SIXTH JOINT INVENTOR, IF ANY	SIGNATURE	DATE
RESIDENCE	CITIZENSHIP	
POST OFFICE ADDRESS		
FULL NAME OF SEVENTH JOINT INVENTOR, IF ANY	SIGNATURE	DATE
RESIDENCE	CITIZENSHIP	
POST OFFICE ADDRESS		
FULL NAME OF EIGHTH JOINT INVENTOR, IF ANY	SIGNATURE	DATE
RESIDENCE	CITIZENSHIP	
POST OFFICE ADDRESS		
FULL NAME OF NINTH JOINT INVENTOR, IF ANY	SIGNATURE	DATE
RESIDENCE	CITIZENSHIP	
POST OFFICE ADDRESS		